

C L A I M S

1. A magnetron plasma processing apparatus which comprising:

a chamber with an outer wall that can maintain
5 reduced pressure;

a pair of electrodes arranged in said chamber to
oppose each other and to define a processing space
therebetween;

process gas supply means for supplying a process
10 gas into said chamber;

electric field forming means for applying
a voltage to said pair of electrodes, thus forming
an electric field in the processing space; and

magnetic field forming means for forming, in the
15 processing space, a magnetic field perpendicular to
a direction of the electric field and directed in one
direction, wherein

a target substrate is subjected to a magnetron
plasma process while the target substrate is set in
20 the processing space to be parallel to said electrodes,

said magnetic field forming means including
a dipole ring magnet comprising a plurality of first
anisotropic segment magnets arranged in a ring-like
shape around the outer wall of said chamber so as to
25 form a magnetic field gradient, in a plane
perpendicular to the direction of the electric
field, such that a magnetic field strength is large and

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small on upstream and downstream sides, respectively,
in an electron drift direction along a direction
perpendicular to a direction of the magnetic field,

at least one second anisotropic segment magnet,
5 arranged in the vicinity of a predetermined region
located outside that end of the target substrate which
is on an upstream side in the electron drift direction,
with an N pole thereof being directed toward the
predetermined region, and

10 at least one third anisotropic segment magnet
arranged in the vicinity of the predetermined region
with an S pole thereof being directed toward the
predetermined region,

15 said second and third anisotropic segment magnets
serving to locally increase a magnetic field of the
predetermined region to be larger than that formed by
said first anisotropic segment magnets.

2. A magnetron plasma processing apparatus
according to claim 1, wherein said second and third
20 anisotropic segment magnets are disposed in a ring-like
shape together with said first anisotropic segment
magnets.

3. A magnetron plasma processing apparatus
according to claim 2, wherein said second and third
25 anisotropic segment magnets are arranged continuously.

4. A magnetron plasma processing apparatus
according to claim 3, wherein said first to third

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anisotropic segment magnets are columnar magnets of the same strength which are magnetized in one direction, and said first anisotropic segment magnets are arranged such that directions of magnetization thereof are slightly shifted from each other.

5 5. A magnetron plasma processing apparatus according to claim 4, wherein said first anisotropic segment magnets are arranged such that gaps among those which are on the upstream side in the electron drift direction are narrower than gaps among those which are on the downstream side in the electron drift direction.

10 6. A magnetron plasma processing apparatus according to claim 1, wherein said first anisotropic segment magnets form a magnetic field with 200 Gauss at maximum at a portion thereof opposing the target substrate, and said first to third anisotropic segment magnets form a magnetic field of at least 200 Gauss at the predetermined region.

15 7. A magnetron plasma processing apparatus comprising:

20 a chamber which has an outer wall and can maintain reduced pressure;

 process gas supply means for supplying a process gas into said chamber;

25 a pair of electrodes arranged in said chamber to oppose each other and to define a processing space therebetween;

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electric field forming means for applying a voltage to said pair of electrodes, thus forming an electric field in the processing space; and

5 magnetic field forming means for forming, in the processing space between said pair of electrodes, a magnetic field perpendicular to a direction of the electric field and directed in one direction, wherein

10 a target substrate is subjected to a magnetron plasma process while the target substrate is set in the processing space to be parallel to said electrodes,

15 said magnetic field forming means including a dipole ring magnet comprising a large number of anisotropic segment magnets arranged in a ring-like shape around the outer wall of said chamber, to form a gradient of the magnetic field, in a plane perpendicular to the direction of the electric field between said electrodes, such that a strength of the magnetic field is large and small on upstream and downstream sides, respectively, in an electron drift direction along a direction perpendicular to a direction of the magnetic field,

20 said plurality of anisotropic segment magnets including a first section comprising at least one anisotropic segment magnet arranged in the vicinity of a first region located outside that end of the process substrate which is on the upstream side in the electron drift direction with an N pole thereof being directed

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toward the first region, and a second section comprising at least one anisotropic segment magnet, arranged in the vicinity of a second region located outside that end of the target substrate which is on the upstream side in the electron drift direction, to be away from the first region, with an S pole thereof being directed toward the second region, the first and second sections serving to locally increase magnetic field strengths of the first and second regions.

8. A magnetron plasma processing apparatus according to claim 7, wherein at least another anisotropic segment magnet is arranged between the first and second sections.

9. A magnetron plasma processing apparatus according to claim 8, wherein said anisotropic segment magnets are columnar magnets of the same strength which are magnetized in one direction, and those of said anisotropic segment magnets which are at a portion other than the first and second portions are arranged such that directions of magnetization thereof are slightly shifted from each other.

10. A magnetron plasma processing apparatus according to claim 9, wherein first anisotropic segment magnets are arranged such that gaps between those which are on the upstream side in the electron drift direction are narrower than gaps between those which are on the downstream side in the electron drift

direction.

11. A magnetron plasma processing apparatus according to claim 7, wherein said anisotropic segment magnets form a magnetic field with 200 Gauss at maximum at a portion thereof opposing the target substrate, and form a magnetic field of at least 200 Gauss at the predetermined region.

12. A magnetron plasma processing apparatus comprising:

a chamber to which a process gas is to be supplied;

a pair of electrodes arranged in said chamber to oppose each other and to define a processing space therebetween;

electric field forming means for applying a voltage to said pair of electrodes, thus forming an electric field in the processing space; and

magnetic field forming means for forming, in the processing space between said pair of electrodes, a magnetic field perpendicular to a direction of the electric field and directed in one direction, the magnetic field having, at a portion other than that end of a target substrate which is on an upstream side in an electron drift direction, a magnetic field gradient, within a plane perpendicular to the direction of the electric field between said electrodes, such that a magnetic field strength is large and small on

the upstream and downstream sides, respectively, in
the electron drift direction along a direction
perpendicular to a direction of the magnetic field,
the magnetic field strength being locally large at that
5 end on the upstream side, said magnetron plasma
processing apparatus serving to subject the substrate
to a magnetron plasma process while the target
substrate is set in the processing space to be parallel
to said electrodes.

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